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ABSTRACT

An overview is provided of the Management Information System for Occupational Education (MISOE). MISOE is described as an interactive, computerized information system designed to be prototypical for the statewide management of education and to help managers at all levels better understand, through numerical analysis of past experience, the causal relationships between current policy and future results. Part I of the report outlines the structure and scope of MISOE, discussing the system's data files, its sampling design, and its data system index. Part II focuses upon policy analysis and data analyses within MISOE and describes dynamic simulation, a process which relates the future consequences of current decisions made within the context of a complex social system. Part III deals with the potential which MISOE has for improving the quality of human life. (Author/PB)

A Prototype

Computer-Assisted Planning for Education

Management Information System for Occupational Education (MISOE)

Description & Perspective in Three Parts

Part I

A Description of MISOE

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Part II

Policy-Oriented Analysis in an Interactive System

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American Council on Education

Part III

The Challenge in MISOE

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American Educational Research Association
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PART I

A DESCRIPTION OF MISOE

by

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Fortunately, the developing and prototypical management information system which John Creager, David Tiedeman and I are going to set forth for you today is fairly well presented in the 1973-74 Winter Issue of the Journal of Research and Development in Education. Given the existence and ready availability of this Journal, we have decided that our task today should be to suggest the essence, scope and structure of the development we have named MISOE, which is an acronym for the Management Information System for Occupational Education. If the Conroy, Creager, Tiedeman trilogy succeeds, those in attendance who are able to focus some attention upon our performance will either be spared the dreary experience of struggling with yet another description of a management information system, or have sparked a desire to further pursue our work as a potentially useful experience. Needless to say, the reality of MISOE is the result of many diligent and delightful people, most of whom are not here today. They all contributed to the Journal account of MISOE, and, together, are fundamentally responsible for MISOE's being.

Creager and I will describe the scope and structure of MISOE, while Tiedeman will offer observations on the challenge in MISOE to make better the quality of life for human beings everywhere. Specifically, I will first outline the data files, sample design and data system index, and then John Creager will target his remarks to data analysis within MISOE. Creager, Tiedeman and I will talk about dynamic simulation, a process we have incorporated into MISOE to help man understand better the future consequences of current decisions when dealing with complex social systems. Dynamic simulation is a development of Professor Jay Forrester of the Massachusetts Institute of Technology. Creager will illustrate the technique somewhat more than I have

time to do. Tiedeman will pick up the feed forward potential of dynamic simulation and illustrate its potential value and challenge.

It is appropriate to introduce a description of some of the technical components of MISOE with a statement of purpose. The single purpose of MISOE is to provide a computerized, information support capability to those charged with the responsibility of managing occupational education at the state level. MISOE has been purposefully designed to support the planning process by allowing man the manager easy access both to information and to operations to analyze information, such that experience can influence the process of policy formulation. MISOE has been developed on the fundamental assumption that if man can self-initiate an interaction with numerical descriptions of past experience, he will be better able to understand the likely outcomes of current policy. To try to accomplish this goal, MISOE has added what we like to call "state of the art" computer technology to provide man as manager a capacity to enter into an interactive dialogue with experience.

MISOE conceives of resource allocation as the fundamental state level planning function for occupational education, i.e., assigning funds to specified alternatives which are designed to cause specified outcomes to occur. MISOE thinks of planning as including a description of program characteristics, a stipulation of the types and numbers of students to be served, and statements describing the desired outcomes for the students who experience the planned

process, as well as the impact of the educationally influenced students upon society as a whole. Such plans must include a description of private and social costs and an explicit estimation of the economic benefits for society and the so-called target student. MISOE provides information for planning at three distinct levels:

(1) The Overall Social Agency Level - This planning is typically done by the legislature and determines the optimal mix of education with other social service agencies provided to achieve desirable societal goals.

(2) The Overall Education Level - This planning is usually done by a Chief State School Officer and staff who determine the optimal mix between occupational and nonoccupational education to attain desirable societal goals.

(3) The Within Occupational Education Level - Planning at this level is most frequently done by a division or bureau within a state department, and decides the occupations for which students can decide to become prepared, the specific occupational capabilities within programs which students can learn, and the program characteristics which seem most likely to facilitate learning for discrete groups of students.

Finally, MISOE has the audacity to consider itself prototypical for policy making in all education, and assumes that occupational education is a tolerated educational alternative because of its perceived contribution to desirable social goals. The essence of MISOE is to help man the manager at all three policy making levels better understand, through numerical analysis of past experience, the causal relationships between current policy and future

results for a complex social service, competitively functioning in a reasonably free society.

It is now time to outline the data files and sampling design of MISOE. A full treatment of our "data rich" development can be found in the previously cited Journal.

MISOE is comprised of two major and connected data systems, one we call the Census Data System (CDS) and the other the Sample Data System (SDS). CDS is comprised of essential information on all schools which meets basic accountability responsibilities, including enrollments by grade, occupational education programs, terminal performance objectives (TERMOBS) attained by student groups within occupations, as well as expenditures by program, capacity and utilization descriptions by programs and a specification of some staff and student characteristics. As you probably know, it is not easy to develop a Census Data System in which the information is sensibly crossed, so that a user can know enrollment by grade, sex, race and occupation. Too many state-wide census information systems are merely a nonrational mosaic of compliance data, rarely providing an accurate description of practice. MISOE has labored long and hard to develop a census data system which, while meeting all compliance regulations, also provides information for policy making in a way that integrates occupational education with total education. CDS is coded so it is maximumly connectible and provides breakouts for a variety of geographical and school type variations.

A separate word needs to be spoken about TERMOBS, or terminal program objectives. About three years of intensive developmental has yielded a flexible process by which students, faculties and schools can explicitly communicate specific occupational skills students are attempting to

learn within or across occupations. Although TERMOBS allow a communication of explicit skills for groups of students by program, they are formulated in a way that does not encourage movement toward the development of constant standards for all students within programs. They are well-documented in the Journal, and we have them fully developed for about 80 per cent of the enrollment in occupational education in Massachusetts. On the average, 50 - 70 TERMOBS are sufficient to describe the occupational competency for each of the 90 occupations for which occupational instruction is currently offered in Massachuset

MISOE sample data systems are longitudinal, i.e., data is aggregated to the same individual over time. The specific data types of what we call Generation I MISOE can probably be best understood from the framework of a fairly simple-minded conceptual structure we evolved, comprised of four separate parts: input, process, product and impact. The MISOE input battery includes measures of achievement, ability, personality and estimations of socio-economic and so-called contextual variables, describing the student at entry into the program. Process variables include measurement of staff characteristics, faculty planfulness, moonlighting, inbreeding, technical experience, attitudes toward students by faculty, staff morale, etc. The product battery consists of students' scores on TERMOBS, as well as a measure of general educational development. Impact information includes a description of students' post program lifestyle, including: economic, social, community, family and governmental behavior, as well as an employee rating scale which attempts to assess productivity. MISOE sample data systems include an estimation of cost by program (on a per student basis).

In addition to the array of descriptive information yielded by the MISOE design, major analytical data types include:

(1) Process-Product Information - which describes relationships between process elements and resulting product; namely, general educational development, TERMOBS and number of completors.

(2) Cost Effectiveness Information - which is a way of relating expenditures to product.

(3) Cost Impact (Benefit) Information - which seeks to estimate the costs of occupational education to the resulting benefits to society or specified individuals. The Journal includes a chapter entitled "Economics of Public Investment in Education and MISOE Cost Analysis Systems".

The MISOE sampling design crosses school types (comprehensive, self-contained-vocational and community colleges), level (secondary, post-secondary and adult) with geographic region (large cities, medium cities and towns). It includes forty schools and 15,000 students, with 12 separate geographic-school type cells each including most of the high enrollment occupational education programs in Massachusetts, as well as a nonoccupational education comparison group. First stage sampling weights are the inverse of sampling ratios, while a second stage of sampling is attained within programs from schools randomly selected in Stage I. The weights actually applied to student data for computing aggregate estimates and for conducting analyses relevant to the population will be the product of the first stage and second stage weights. Because MISOE has decided upon two stage sampling with disproportionate stratification, the typical formulae for the standard error of commonly used statistics are not applicable.

I would like to conclude my section of the presentation with a brief description of how MISOE has been designed to help man interpret experience in developing policies with an improved understanding of the consequences of each

policy statement. Generation I MISOE was developed on the shaky assumption that its data files included important, but hardly exhaustive, elements which come into play in the development of policies for occupational education at the state level. As a result of a dedicated and brilliant staff, a merger of developed statistical and data management packages with executive programming is 'coming up' which, together with developed indices to the sample and census data systems, as well as an array of logical and analytical operations, allows man the manager to browse MISOE data files in search of information which could affect current policy. MISOE is an on-line system, with a "scoped" terminal and mini-computer, as well as a hard copy device. Batch output is also possible, and output can be tabular or graphic. MISOE is being designed so that few technical skills are required to enter into dialogue with the data files. The Journal includes a fairly complex example of "policy making with machine."

When man as a determiner of social policy interacts with MISOE as described in the Journal, he could be described as operating from a model or conception of the world at large. His dialogue with experience expands his understanding about the world. His world conceptual model is more or less constrained by the number of elements and relationships he can juggle in his mind at one time. Often, the development of social policy involves 'juggling' more elements at one time than man can cognitively accommodate. Dynamic simulation offers a computer assisted methodology to deal with and develop understandings about complex social issues. Unlike other techniques (mathematical programming), its fundamental purpose is not to specify optimum (and simplified) solutions to complex problems, but rather to contribute to the development of an understanding on the part of human managers about the fundamental nature of

causal relationships among elements relevant to a particular social policy in formulation. Dynamic simulation is technically operational within the hardware configuration described above.

Now to discuss the scope and structure of MISOE analysis alternatives within data files, with particular attention to implications for policy making, I am delighted to present the co-architect of the MISOE Sample Data System, John Creager of the American Council on Education, Washington, D. C.

PART II

POLICY-ORIENTED ANALYSIS IN AN INTERACTIVE SYSTEM

by

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The structure and scope of MISOE, as just described by Dr. Conroy, constitutes a documented data base of interconnected information on students, teachers, administrators, schools, and programs. With MISOE's longitudinal design, the double connectability over observation units and time is just what is needed and is so often lacking in educational data bases...if they are to be useful to managers of educational systems in policy formulation and decision making. With such a data base accessible to the manager via a scope terminal in his office, information and analytic results can be quickly retrieved in a series of probes which he, the manager, defines according to his needs. The results of each probe stimulate the manager to define the next probe. Thus, MISOE is an interactive system.

Management is inherently policy-oriented: either the manager is formulating policy, implementing it, or evaluating how it is working. For this he needs the information in the data base and the results of various levels of analysis of that information. Often he only needs simple descriptive information about the domain of his responsibilities and concerns: distributional information and summary statistics on enrollments, costs, and program completion or attrition such as that available from the Census Data System of MISOE.

An educational manager who defines his task as facilitation of student development will need similar statistical information about students: what they are like when they enter a program, what characteristics of the educational process they have been exposed to, what specific skills they have learned. And when we think of characteristics of the educational process, we cannot forget the teacher and administrator as inherent parts

of that process. Nor does such a manager forget that the educational process is supported by a society that rightly expects something in return for its investment, i.e., impacts on society of a skilled and productive citizenry. Each of these concerns can be met in part by the relatively simple descriptive level of analysis, using the information in the Sample Data System. To know, qualitatively and quantitatively, what it is one is trying to manage and the level of resources available to accomplish organizational goals is the first step in management. If his domain is complex, or heterogeneous, there is too much to keep in mind at once, properly sorted out in required categories, even if the information is stored in a systematic way. More likely, he has bits and pieces of information scattered throughout reports and the heads of subordinate personnel...if he can just remember where to look for the information desired. How much easier to walk over to the terminal and query the data base, getting what he needs in the form he needs, and in reasonable time!

A manager may be faced with a definite but general problem, e.g., high overall attrition of students in occupational education. To analyze his problem as a possible failure of educational policy, he needs diagnostic listings and comparative statistics by type of school, type of student, and by program in order to identify where high attrition is occurring. To obtain this information, he must specify to the information system the parameters of a single probe: one or more targets, criteria, output modes, and classifications. In a comparison of attrition rates among programs, the target population is students in occupational education, the criteria may be the number of completors, number of noncompletors,

total, and percent attrition, the output mode a tabular display at the terminal of these data, classified by program and some student type variables. Having obtained this information, he may wish to examine the attrition rates in various schools giving this program -- another probe with slightly changed parameters. Alternatively, he might have done both on a single probe by calling for a classification parameter of schools within programs or programs within schools. Further probes could also determine whether attrition in the longer programs occurs early or late in the program sequence. A somewhat different kind of probe, determining whether higher attrition occurs in high cost or low cost programs, capitalizes on the ability to relate the economic and noneconomic components of the data base. The manager might also want to compare completors and noncompletors on impact variables to ascertain the long-run nature and seriousness of the problem.

Having thus obtained a rather more precise idea of the nature of his attrition problems by working interactively with actual data, the manager may now begin to play his hunches about policy changes he needs to make in order to ameliorate the situation. This may well involve probes calling for a higher level of correlation or regression analysis. For example, he might want to call on stepwise regression to help pick those process variables, such as student attitudes toward their program or teacher characteristics, that might be adjusted by certain policy changes. For this the student might be the unit of analysis and completion vs. noncompletion the criterion or dependent variable. Better yet, he might do a two-stage regression analysis, first regressing the attrition criterion on student input characteristics, and then regressing the residuals on the process

variables. The first stage regression may be useful not only in isolating student input variables related to attrition, and possibly controlled by guidance procedures, but also in controlling the process analysis for such input characteristics. Such analyses capitalize on the longitudinal elements of MISOE and the connectability of data across observation units.

While time does not permit detailed delineation of the nature and order of probes for the various possible results of each interim probe, one can begin to appreciate the flexibility and generality of MISOE as a management tool even for a particular area of concern, like attrition. Certainly, the choice and sequence of probes might well be different for a different general problem. For example, the manager may be faced with the complaint that cost rather than attrition is too high. Before blindly supporting and implementing a policy of wildly wielding the budgetary ax, he may want to look carefully at benefits as well as costs. If he must still cut total costs, he may well want to adopt policies that involve minimum loss of benefits. Conversely, he might develop a position requiring closer priority considerations of the benefits, which would then be achieved under a policy of minimizing costs under specified constraints. This is not the kind of real problem that even a genius manager can solve by gathering partial and disconnected information from the field and then staring at the ceiling. Much less can most managers afford to have at hand a well-chosen and functioning research unit with its own ad hoc computerized data base developed for each problem that comes along.

The policy-oriented analysis system of MISOE, designed for interactive support of management has another major feature, noted Dr. Conroy,

and called "dynamic MISOE." Also interactive, dynamic MISOE permits the manager to look at policy implications over time as a gestalt, by using a class of models called, "dynamic simulation." These models have demonstrated utility in certain industrial applications and interesting, though speculative possibilities in demographic, economic, and other applications. Their potential for the formulation and evaluation of educational policy remains to be demonstrated. The development of MISOE has envisioned such a possibility by providing the capability for management-interactive generation of such models with the data base supplying the empirical values of model parameters. The manager can use a given model in either of two ways: (1) running the model with status quo parameter values retrieved from the data base to ascertain long-range consequences of present policy, and (2) manipulating certain parameters which reflect contemplated policy changes. This enables him to ascertain consequences before such policy changes are, in fact, implemented. In that way, he can be alerted to unexpected side-effects and interactions in the system, resulting from an otherwise highly plausible policy change. The role of management in formulating such models is regarded as critical, if such models are to be useful to management in policy decisions.

Although MISOE has been designed to support the manager of occupational education in a particular state system, the basic principles of its design are applicable to similar systems for other states, and for systems supporting managers of other levels and sectors of the educational enterprise. The educational researcher has a critical role in the design and implementation of such management information systems to ensure their scientific integrity, without which the manager's interactive use in policy decisions would be dangerous, rather than useful, in meeting his responsibilities.

PART III

THE CHALLENGE IN MISOE

by

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The Ordinary in MISOE

In one way, MISOE merely represents an application to the management of occupational education of a development which has been going on among computer circles for over two decades, namely the provision of compatible data files and packages of statistical analyses which permit thorough statistical analysis of individually selected data. The key to such potential is the writing of a statistical package with allowance for input of variable parameter designations probably appropriate for anticipated uses of the package. But the key to successful use of such packages is user familiarity with the available techniques and user ingenuity in fitting his supplied or picked numerical data to the structure of the pre-formed analyses.

The Contributions of MISOE

In other ways, however, MISOE strikes out on its own in the history of making computer systems adjuvant to thinking. Some of the new ways in which MISOE provides individuation of numerical analysis are quite obvious, others less obvious. Among the more obvious new departures are the following:

1. introduction of the capacity to generate representative samples by virtue of the availability of population data and the capacity to deal with weighted as well as unweighted data;
2. the raising of the regularly available interactive capacity of recycling analyses to an on-line status in which the delays between a command and its execution can be lowered to a state in which the user can quite figuratively browse through data files and analyses in order to let his intuition have freer play in his attempt to understand what his data indicate; and
3. the joining of analytic and diagrammatic output so that results can have visual as well as conceptual impact.

MISOE's less obvious but very powerful departures from the ordinary developmental lines of interactive numerical analyses include the following:

1. the capacity to treat product data in ipsative terms so that the user can give meaning to results in terms known to students and their parents not just in terms of normative comparisons;
2. the capacity to relate costs with effects so that cost benefit and cost efficiency considerations can be brought into play; and
3. the capacity to develop expectable futures to which another can attach the same degree of credibility as the inventor of a possible future by repeating the dynamic simulation until alternative models are reasonably exhausted.

The Challenge in MISOE

But the most subtle departure from the ordinary developmental lines of interactive numerical analysis is MISOE's declared plan to operate as a

network. Data are to be assembled at local and Commonwealth levels. Computational power is being arranged to address questions in local program invention and operation, and in legislative policy making. There are fortunately no present plans to restrict address of any part of the system to any class of user. This means that in addition to the questions appropriate to the level at which each works, local program administrators can ask Commonwealth and legislative questions, Commonwealth administrators can ask local and legislative questions, and legislators can ask local and Commonwealth questions. In contradistinction to present suspicions which currently limit each group to the questions at only its own level, MISOE can therefore materially increase communication and understanding among local and Commonwealth administrators and legislators. Through MISOE each can satisfy himself that the other is doing the best he can or else generate data publicly transmissable which ought to convince the party in need of change of the bases on which that change ought to be predicated and pursued.

In union with a network policy of operation, dynamic analysis offers visionary citizens and administrators the power to think divergently with a system that converges in its limits. This power stems from the fact that the user has to operate on his variables in dynamic analysis in order to move effects from a state which is not desired into another state which is desired. This requires that the user not alone think relationally; he must think functionally as well. He must chain effects into sub-systems in which a causes b and b causes c, etc. Means lead to ends but in the end the user will find that one end in reality merely becomes the means to a larger end, etc. Furthermore, he must begin to estimate rates in order to see how long it will take a to become b, etc. under his assumptions. Citizens and administrators who allow themselves time to become familiar with such

technique and thinking will find that they can chart quite considerable pathways into the future with quite strong feelings that they know what is likely to happen within relatively narrow time spans provided certain conditions can be made to exist. The effects which MISOE seeks to effect in citizens and administrators who would allow themselves to play with its capability for dynamic analyses is that which an insurance agent seeks on his customers, namely a look into the future and its potential and relatively certain consequences which is sufficiently detailed and clear to give the potential customer the personal conviction that he must act now, in such and such ways, to get what he seeks by "x" years from now. Dynamic analysis can build the consciences of occupational education's customers and administrators to such a point that they become more rational users and guides, not the somewhat irrational network they are, and will remain, in the absence of dynamic analysis in a MISOE network.

Although I intentionally accord MISOE great potential, I am realist enough to anticipate problems for MISOE as well. In order for MISOE to work, it must have data, not enormous sets of missing observations. It must be open to all users, not closed to many users. It must be consultative, not dictatorial. It must be synergistic, not competitive. Such conditions will not easily materialize. Some of the difficulties now readily discernible are as follows:

1. local schools and the Commonwealth's Department of Education itself must all agree to participate in MISOE for it to work;
2. there are rather high implementative costs which must be borne to collect MISOE's data, maintain its data files, and operate it as a consultative adjuvant interactive computational facility;
3. there are computational and display difficulties of high magnitude which must be worked through before the adjuvant interactive

computational facility will become as commonplace and reliable as the telephone; and

4. the difficulties which naive users will at first experience will cause the near sighted to argue that a state facility ought to do the computation for a user, not provide the adjuvant interactive computational capacity in which any Tom, Dick and Harry who thinks he can decide better than a legislator, the Commonwealth's Associate Commissioner for Occupational Education, or a local system's director of occupational education can actually test his assumptions.

If we self defeatingly accept anticipated use difficulties as insurmountable, MISOE will quickly die. However, if we face these difficulties as good teachers face the learning difficulties of their students, namely as difficulties to be borne and surmounted, not as difficulties to truncate belief in solution, MISOE will live. If MISOE lives, educational administration will be brought to a new level of technical undergirding. But most importantly, if MISOE lives, education will be potentially returned to parents through their potential control of the future on a footing equal to that of educational administrators. When parents can function as informed and surrogate educational administrators with the resources available to all in a state, students will at last get the message that education is for and in them, not done for them by others. Education desperately needs the dawning of such a day.